Grade 6 Standards and Learning Activities

SCIENTIFIC THINKING AND INQUIRY

6.1. Broad Concept: Scientific progress is made by asking relevant questions and conducting careful investigations. As a basis for understanding this concept, and to address the content in this grade, students should develop their own questions and perform investigations.

Students:

1. Give examples of different ways scientists investigate natural phenomena, and identify processes all scientists use, such as collection of relevant evidence, the use of reasoning, the development and testing of hypotheses, and the use and construction of theory to make sense of the evidence.
2. Plan and conduct simple investigations based on student-developed questions that pertain to the content under study, and write instructions others can follow in carrying out the investigations.
3. Identify dependent and independent variables in those investigations that have controls. If no controls are used, explain why.
4. Recognize and explain that hypotheses are valuable even if they turn out not to be true, but that many investigations are not hypothesis-driven.
5. Write a report of an investigation that includes the problem to be solved, the methods employed, the tests conducted, the data collected or evidence examined, and the conclusions drawn.
6. Locate information in reference books, back issues of newspapers and magazines, CD-ROMs, and online databases.
7. Draw conclusions based on scientific evidence, and indicate whether further information is needed to support a specific conclusion or to discriminate among several possible conclusions.
8. Record and organize information in simple tables and graphs, and identify relationships they reveal. Use tables and graphs as examples of evidence for explanations when writing essays or writing about lab work, fieldwork, etc. Read simple tables and graphs produced by others, and describe in words what they show.
9. Read a topographic map and a geologic map for evidence provided on the maps.
10. Construct and interpret a simple map.

Examples

Students gather and evaluate current evidence on the short- and long-term effects of space travel (6.1.3 and 6.1.8).

Students examine Einstein's imagination and ideas, his mistake in calculating the gravitational constant for the universe, and how challenging it would be to break with traditional ideas about gravity (information available at www.amnh.org/exhibitions/einstein) (6.1.4).

Students investigate the varying effects of air resistance on objects dropped from greater heights (6.1.5).

Using data collected over the past 100 years, students analyze the intensity of landfall hurricanes in the Atlantic basin and draw conclusions about past cyclic patterns of intensity by hurricane season. They determine whether or not the current year represents an anomaly in the cycle trends (6.1.7).

Students choose a small area of unpaved, sloping ground in the schoolyard or a park. They create a scale contour map of the area, including true north and magnetic north (6.1.10).

SCIENCE AND TECHNOLOGY

6.2. Broad Concept: Although each of the human enterprises of science and technology has a character and history of its own, each is dependent on and reinforces the other. As a basis for understanding this concept,

Students:

1. Explain that computers have become valuable in science because they speed up and extend people's ability to collect, store, compile, and analyze data; prepare research reports; and share data and ideas with investigators all over the world.
2. Explain that technology is essential to science for such purposes as measurement, data collection, graphing and storage, computation, communication and assessment of information, and access to outer space and other remote locations.

Example *Students research current technology used to create maps, such as remote sensing satellites that generate geothermal activity/digital/analog images, and GPS systems (information available at www.usgs.gov) (6.2.2).*

THE SOLAR SYSTEM

6.3. Broad Concept: Astronomy and planetary exploration reveal the structure and scale of the solar system. As a basis for understanding this concept,

Students:

1. Recognize that the solar system consists of the Earth, moon, sun, eight generally recognized other planets that orbit the sun and their satellites, and smaller objects, such as asteroids and comets.
2. Describe how the planets move around the sun in elliptical orbits, and explain how the near coplanarity of the orbits, along with the principle of conservation of momentum, is evidence essential to our understanding of how the solar system was originally formed.
3. Explain that the moon is Earth's only natural satellite, but several of the other planets have natural satellites as well. Understand Earth also has many artificial satellites and that all of these satellites, artificial and natural, are in elliptical orbits around their primaries.
4. Explain that large numbers of chunks of rock and ice (asteroids and comets), much smaller than planets, orbit the sun.
5. Describe, as seen from Earth, how planets change their position relative to the background of stars.
6. Construct models or drawings to explain that the seasons are caused by the tilt of the Earth's axis relative to the plane of its orbit and its revolution around the sun. Explain how this results in uneven heating of the various parts of Earth's surface that varies over the course of the year.
7. Describe that as spring turns to summer at a particular place on Earth, the days grow longer and the sun moves higher in the sky, resulting in more intense heating. In fall and winter, the opposite occurs. Explain how this variation in heating results in the seasons.
8. Recognize and describe the sun as a midsize star located near the edge of a disk-shaped galaxy of stars called the *Milky Way.* Recognize that the universe contains many billions of galaxies, and each galaxy contains many billions of stars.

THE SOLAR SYSTEM (CONTINUED)

9. Recognize that the sun-to-Earth distance is such that it takes about eight minutes for light from the sun to reach Earth. Know that the next nearest star is many thousands of times farther from Earth, and its light takes about four years to reach Earth.

10. Explain that gravity is a force of attraction that every mass in the universe exerts on every other mass, and everything on or anywhere near Earth is attracted toward and attracts Earth's center by a gravitational force.

11. Describe that the sun's gravitational attraction holds Earth and the other planets in their orbits, just as the planets' gravitational attraction keeps their moons in orbit around them.

Examples *Students create elliptical orbits, using string, pushpins, and a pencil. They use various string lengths to simulate ellipses of Pluto, Jupiter, Earth, and Mercury. They try to roll a ball along the elliptical orbits, and discuss the kinds of forces that have to be present to keep the ball moving in that direction (6.3.2).*

Students observe seasonal star charts of the night sky and track the location of major star constellations during each season. They create a map of one of the stellar constellations and relate the movement or change in location to the Earth's rotation and revolution, rather than to the movement of the star group (6.3.5).

Students examine the differences that are created in the Earth's climate by adjusting the orbit, tilt, and axis wobble of the Earth (6.3.6).

Students use the concept of gravity to explain why people can jump higher on the moon than they can on Earth (6.3.10).

Students change and adjust the places of the planets to observe a simplified simulation of the changed effects of gravity (information available at arachnoid.com/gravitation) (6.3.11).

HEAT (THERMAL ENERGY)

6.4. Broad Concept: The transfer of energy through radiation and convection currents affects many phenomena on the Earth's surface. As a basis for understanding this concept,

Students:

1. Explain the meaning of radiation, convection, and conduction (three mechanisms by which heat is transferred to, through, and out of the Earth's system).

2. Describe that the heat from the sun falls on Earth unevenly because of its spherical shape. Describe that regions close to the equator receive more concentrated solar energy than those closer to the poles.

3. Observe and explain how uneven heating sets up convective cells in the atmosphere and oceans that distribute heat away from the equator.

4. Explain that much of the heat from the sun is absorbed by the land and oceans and then is released into the atmosphere.

5. Recognize that, compared to other substances such as rock and soil, a given mass of water requires a greater input or output of heat energy to change its temperature by a given amount.

HEAT (THERMAL ENERGY) (CONTINUED)

6. Describe why ocean temperatures, therefore, tend to vary seasonally less than land areas and why coastal areas tend to have cooler summers and warmer winters than inland areas at a similar distance from the poles.

Examples *Students investigate the movement of a drop of food coloring placed in water, with and without a heat source, and in different positions relative to a heat source (6.4.1 and 6.4.3).*

Students investigate heat transfer by placing plastic, metal, and wooden spoons in hot water and determining how quickly they heat up (conduction) (6.4.1).

Students shine a flashlight on the center (or "equator") of a beach ball and measure from the "equator" the region where the light from the flashlight no longer reaches. Students repeat the procedure with a cardboard box of the same size as the beach ball and contrast their measurements (6.4.2).

Students map prominent wind currents (easterlies, westerlies, trade winds) and research their effects and relationship to ocean current patterns (6.4.3).

Students create a terrarium. They measure the temperature of soil, sand, rock samples, and saltwater before and after heating with a heat lamp. They compare the ability to absorb or resist temperature changes, and predict similar effects in similar regions of the planet (6.4.4 and 6.4.5).

WEATHER AND CLIMATE

6.5. Broad Concept: Weather (in the short run) and climate (in the long run) involve the transfer of energy in and out of the atmosphere. As a basis for understanding this concept,

Students:

1. Explain how different regions receive different amounts of solar heating because of their latitude, clouds, surface water ice, and other variables. Understand that this results in large-scale convective air flow and weather patterns.
2. Recognize and describe that the currents in the air and ocean distribute heat energy.
3. Explain that a great deal of heat energy is absorbed when water evaporates and is released when it condenses. Illustrate that this cycling of water and heat in and out of the atmosphere plays a critical role in climatic patterns.
4. Explain how mountain ranges and other major geographical features affect the climate (e.g., mountains produce rain shadows, land masses interrupt ocean currents).
5. Describe how climates may have changed abruptly in the past as a result of changes in Earth's crust, such as gas and dust from volcanic eruptions or impacts of meteorites, asteroids, and comets from space.
6. Describe how the Earth's atmosphere exerts a pressure that decreases with distance above sea level and, at every point, is the same in all directions.

Examples *Students compare regional wind patterns in one season and then plot the wind directions on a regional map. They compare those patterns with national weather maps collected over the season (6.5.1).*

WEATHER AND CLIMATE (CONTINUED)	
	Students measure the latent heat of water by taking the temperature of ice as it melts to water and water as it boils. Students relate this information to recent data on the suspected effects of global warming on glaciers (6.5.3). *Students compare climates west and east of the Rockies, Andes, and Ural mountain ranges and explain why rainfall amounts, temperature, winds, and types of plants and other life-forms differ (information available at www.nationalgeographic.com/xpeditions/hall) (6.5.4).* *Students study reasons for the major extinctions in the past 600 million years, including the Permian extinction and the K-T event (6.5.5).* *Students map atmospheric pressures on a topographic map (6.5.6).*

RESOURCES

6.6. Broad Concept: Sources of materials differ in amounts, distribution, usefulness, and the time required for their formation. As a basis for understanding this concept,

Students:

1. Explain that fresh water is limited in supply and uneven in distribution; describe why it is essential for life as we know it and also for most human activities, including industrial processes.
2. Recognize that fresh water is a resource that can be depleted or polluted, making it unavailable or unsuitable for humans.
3. Recognize that the Earth's resources for humans, such as fresh water, air, arable soil, and trees, are finite.
4. Explain that the atmosphere and the oceans have a limited capacity to absorb wastes and recycle materials naturally.
5. Investigate and describe how pollutants can affect weather and the atmosphere.
6. Explain that recycling, reuse, and the development of substitutes can reduce the rate of depletion of many minerals.
7. Describe that most rainwater that falls in Washington, DC, will eventually drain into the Chesapeake Bay.
8. Explain the important role of the water cycle within a watershed.

Examples	*Students review a chart of the Earth's water budget (available at www.usgs.gov) and create a pie chart of the distribution of water that includes a written explanation of how much of the Earth's water budget is available for life-forms to use (6.6.1).* *Students write an account of what happens to a drop of water and the physical environment through which it flows as it travels from a lake to a river via the Earth's atmosphere. They use that information to understand drought (6.6.2).* *Students examine graphs of human population growth and their resource consumption to determine a sustainable practice of water use today (information available at www.facingthefuture.org) (6.6.3).*

RESOURCES (CONTINUED)	
	Students simulate pollution by blowing out a candle within a container of air and dropping food coloring into a large sample of water each day. They track the effects on their air and water samples over a period of time (6.6.4 and 6.6.5). *Students research the effectiveness of DC's latest recycling initiative. Students create recycling and/or reuse posters that promote the location of local recycling centers and examples of items produced from recycled materials (6.6.6).* *Students investigate local Chesapeake Bay watershed cleanup initiatives (6.6.8).*

THE ROCK CYCLE

6.7. Broad Concept: Rock materials are continuously recycled in the rock cycle. As a basis for understanding this concept,

Students:

1. Recognize minerals are naturally occurring crystalline solids with definite chemical compositions, and identify common minerals using a key to their diagnostic properties.
2. Examine and recognize most rocks are made of one or more minerals.
3. Describe how igneous rocks are formed when older rocks are melted and then re-crystallized. Understand they may be cooled deep in the Earth or at or near the surface as part of volcanic systems.
4. Explain how metamorphic rocks are formed when older rocks are heated (short of melting) and/or subjected to increased pressure.
5. Describe how sedimentary rocks are formed when older rocks are subjected to weathering into sediments, and those sediments are eroded, transported, deposited, then compacted and cemented.
6. Observe and describe common igneous, metamorphic, and sedimentary rocks, including granite, obsidian, pumice (igneous); slate, schist, marble (metamorphic); sandstone, shale, and limestone (sedimentary).

Examples	*Students observe and sketch crystalline structures of common minerals, such as quartz (resistant to weathering), mica (breaks down into thin, flexible shiny sheets), and calcite (soft mineral), and list the chemical compositions of each (6.7.1).* *Students simulate the formation of crystals by first dissolving sugar cubes in water and then observing what happens as the water evaporates and coats the inner surface of the beaker (6.7.3).* *Students model the metamorphic rock process by rolling clay into marble-sized balls, chilling them, and placing them under a heavy object (a brick). They observe what happens as the temperature of the clay increases and the balls are flattened by the brick (6.7.4).* *Students group samples of rock types with corresponding geographical regions (e.g., igneous and metamorphic with the Hawaii Islands chain, and sedimentary rock with the Appalachian Mountains) (6.7.6).*

PLATE TECTONICS

6.8. Broad Concept: Plate tectonics explain important features of the Earth's surface and major geologic events. As the basis for understanding this concept,

Students:

1. Describe the solid lithosphere of Earth, including both the continents and the ocean basins, and how it is broken into several plates that ride on a denser, hot, and gradually deformable layer in the mantle called the *asthenosphere* (weak sphere).
2. Explain why the Earth has a hot interior.
3. Explain how lithosphere plates move very slowly, pressing against one another in some places, pulling apart in other places, and sliding past one another in others.
4. Compare and contrast oceanic plates and continental plates.
5. Explain the process in which plates push against one another; one of them may be dense enough to sink under the other, a process called *subduction.* Explain that oceanic lithosphere may sink under continental or oceanic lithosphere, but continental lithosphere does not subduct.
6. Describe that subducting plates may partially melt and form magma, which rises to the surface as lava to feed volcanoes and form volcanic mountain chains associated with deep-sea trenches.
7. Explain when plates push against each other and neither is dense enough to subduct (both continental), the plates will crumple and fold and form large mountain chains.
8. Explain that earthquakes are sudden motions along breaks in the crust called *faults,* and volcanoes/fissures are locations where magma reaches the surface as lava.
9. Describe how earthquakes and volcanoes often, but not always, occur along the boundaries between plates.
10. Describe that under the ocean basins, molten rock may well up between separating plates to create new ocean floor.
11. Explain how volcanic activity along the ocean floor may form undersea mountains, which can grow above the ocean's surface to become islands (e.g., the Hawaiian Islands).
12. Explain how physical evidence, such as fossils and surface features of glaciation, supports detailed explanations of how Earth's surface has evolved over geologic time.

Examples

Students research and mark the location of volcanic or earthquake activity on a map of tectonic plates. Students associate those locations with tectonic plate boundaries on the ocean floor or within major continents (6.8.1).

Students use an interactive Web site to simulate plate movement in the directions they choose (www.pbs.org/wgbh/aso/tryit/tectonics) (6.8.3).

Students use stacks of colored sponges to represent tectonic plates at a subduction zone or boundary. As the stacks are forced together head-on, students observe the friction and amount of force necessary to push one stack under the other. Students diagram the resulting landmasses (6.8.5).

Students research geological information for recent events, such as the earthquake in Kashmir and the tsunami in Indonesia (6.8.8 and 6.8.9).

PLATE TECTONICS (CONTINUED)	
	Using a map of tectonic plates and plate boundaries, students map recent volcanic eruptions and earthquakes (www.usgs.gov) (6.8.9). *Students map volcanic islands on a world map and write a brief explanation of the relationship of volcanic islands (e.g., the Hawaiian Islands) to tectonic plate boundaries (6.8.11).*

EARTH AND LIFE HISTORY

6.9. Broad Concept: Evidence from rocks allows us to understand the evolution of life on Earth. As the basis for understanding this concept,

Students:

1. Explain how the Earth's surface is built up and broken down by natural processes, including deposition of sediments, rock formation, erosion, and weathering.
2. Describe that the history of life on Earth has been disrupted by major catastrophic events, such as major volcanic eruptions or the impact of asteroids.
3. Explain that although weathered rock is the basic component of soil, the composition and texture of soil and its fertility and resistance to erosion are greatly influenced by plant roots and debris, bacteria, fungi, worms, insects, and other organisms.
4. Explain how thousands of layers of rock confirm the long history of the changing surface of Earth.
5. Illustrate and describe that remains of changing life forms are found in successive layers, although the youngest layers are not always found on top because of the folding, breaking, and uplifting of layers.
6. Recognize that evidence from geologic layers and radioactive dating indicates that Earth is approximately 4.6 billion years old and life on this planet has existed for more than 3 billion years.
7. Observe and explain that fossils provide evidence of how life and environmental conditions have changed.

Examples	*Students visit local areas following storm events to observe and record signs of erosion and weathering (6.9.1).* *Students research and discuss major volcanic eruptions (e.g., in the Philippines, Indonesia, Guatemala) since the 1900s and discuss evidence scientists use to determine the causes and effects of these events (6.9.2).* *Students investigate wetland soil and grow plants in samples of that soil. They attempt to grow similar plants in another soil sample that has been without water, light, or air for a month. They discuss what happens to organic material in anaerobic conditions (6.9.3).* *Students study examples of the different kinds of life present in different eras of geologic time. They determine where older, and often "stranger," life is found (6.9.6).* *Students read and evaluate what fossil evidence of snails in western Egypt reveal about the role weather and climate played in the dispersal of humans out of Africa and into Europe and Asia (6.9.7).*